REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
	Technical Paper	

4. TITLE AND SUBTITLE

Please see attached

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

5d. PROJECT NUMBER
2308

5e. TASK NUMBER
M19B

5f. WORK UNIT NUMBER
346058

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

ERC

8. PERFORMING ORGANIZATION REPORT

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Air Force Research Laboratory (AFMC)
AFRL/PRS
5 Pollux Drive
Edwards AFB CA 93524-7048

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S NUMBER(S)
Please see attached

12. DISTRIBUTION / AVAILABILITY STATEMENT

Approved for public release; distribution unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Leilani Richardson
Unclassified	Unclassified	Unclassified	A		19b. TELEPHONE NUMBER *(include area code)* (661) 275-5015

2308M1 98

MEMORANDUM FOR PRS (In-House Contractor Publication)

FROM: PROI (STINFO) 99 C0825 15 May 2002

SUBJECT: Authorization for Release of Technical Information, Control Number: **AFRL-PR-ED-AB-2002-113**
David Campbell (ERC), "DSMC Study of Flowfield and Kinetic Effects on Vibrational Excitations in Jet-Freestream Interactions"

23rd International Symposium on Rarefied Gas Dynamics **(Statement A)**
(Whistler, Canada, 21-25 July 2002) **(Deadline: 01 June 2002)**

1. This request has been reviewed by the Foreign Disclosure Office for: a.) appropriateness of distribution statement, b.) military/national critical technology, c.) export controls or distribution restrictions, d.) appropriateness for release to a foreign nation, and e.) technical sensitivity and/or economic sensitivity.
Comments:_____

Signature _____ Date _____

2. This request has been reviewed by the Public Affairs Office for: a.) appropriateness for public release and/or b) possible higher headquarters review.
Comments: _____

Signature _____ Date _____

3. This request has been reviewed by the STINFO for: a.) changes if approved as amended, b) appropriateness of references, if applicable; and c.) format and completion of meeting clearance form if required
Comments:_____

Signature _____ Date _____

4. This request has been reviewed by PR for: a.) technical accuracy, b.) appropriateness for audience, c.) appropriateness of distribution statement, d.) technical sensitivity and economic sensitivity, e.) military/ national critical technology, and f.) data rights and patentability
Comments:_____

APPROVED/APPROVED AS AMENDED/DISAPPROVED

_____

PHILIP A. KESSEL Date
Technical Advisor
Space and Missile Propulsion Division

DSMC Study Of Flowfield And Kinetic Effects On Vibrational Excitations In Jet-Freestream Interactions

David H. Campbell

ERC, Incorporated
Air Force Research Laboratory, Edwards AFB, CA

ABSTRACT

Vibrational excitation of molecular species emitting from a jet into a high-speed freestream is a process with importance to the prediction of high-altitude rocket exhaust plume infrared emissions. Accurate predictions of these emissions are necessary for the analysis of potential optical interference of on-vehicle instrumentation. Unfortunately, accurate vibrational excitation collision cross sections are not always available for the species pairs of interest and for the high relative energies encountered in this situation. In addition, accurate nozzle exit plane flowfield characteristics are always a challenge to calculate accurately.

The results of a study to characterize the sensitivity of predicted vibrational excitation to the vibrational excitation cross section and the nozzle exit plane profile will be presented in this paper. The Direct Simulation Monte Carlo (DSMC) computational technique was used to simulate the interaction between a carbon monoxide jet and a high velocity freesteam of oxygen atoms oriented at 90° to the jet flow axis at 150km simulated altitude. A literature value of the vibrational excitation cross section is used as a baseline, and comparative simulations are made for cross sections that vary around that value. Similarly, the nozzle exit plane profile is varied from a "flat" profile to a fully developed laminar boundary layer profile to obtain sensitivities to the jet inflow startline.

SMILE, a software system based on the DSMC method, developed at the Institute of Theoretical and Applied Mechanics, Novosibirsk, Russia, has been utilized for this study. This code is capable of fully 3-D parallel calculations, and has a graphical user interface, xSMILE that automates the process of setting up a case, running the main SMILE code, and obtaining output in a useable form.